UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/688,333	10/17/2003	Uri Cohen	JETS-02	2289

7590 01/25/2007

Uri Cohen
4147 Dake Avenue
Palo Alto, CA 94306

EXAMINER	
WILKINS III, HARRY D	
ART UNIT	PAPER NUMBER
1742	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/25/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	10/688,333	COHEN, URI	
	Examiner	Art Unit	
	Harry D. Wilkins, III	1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 December 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-12 and 21-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-12 and 21-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *07 October 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Status

1. The rejection grounds based on Tzanavaras et al in view of Downes, Jr et al require a certain amount of clarification in view of Applicant's response and declaration. In the interest of providing the best rejection possible, the Examiner is reopening prosecution to clarify the rejections and to introduce a new rejection ground based on a new piece of prior art, Hackett (US 5,368,634).

2. Applicant's remarks with respect to at least claims 4 and 9 with respect to a lack of motivation from Downes, Jr et al to perform the wetting and electroplating steps with the same solution is found persuasive and the rejection grounds of claims 4 and 9 utilizing Downes, Jr et al have been withdrawn.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tzanavaras et al (US 5,421,987) in view of Downes, Jr et al (US 2002/0189637).

Tzanavaras et al teach (see figure 1) a method for electrofilling a metal or alloy inside at least one opening located in a front surface of a substrate, the front surface of the substrate including at least one opening and a top field surrounding the opening, wherein the opening included a bottom and sidewalls coated with an exposed metallic

surface, wherein the steps of the method included immersing the substrate in an activation solution (electrolyte), applying high pressure electrolyte jets to the substrate, wherein the electrolyte included metallic ions of the metal to be plated and applying an electroplating current to the substrate to electroplate the metal inside the opening.

Thus, Tzanavaras et al fail to teach applying ultrasonic or megasonic vibrations to the substrate prior to the onset of electroplating.

Downes, Jr et al teach (see abstract and paragraphs 2-4, 22, 30 and 39-41) applying ultrasonic vibrations to a liquid to ensure adequate wetting of small vias or holes with diameters of 0.001-0.002 inches (~25-50 micrometers) and aspect ratios of 6:1 to 8:1.

Therefore, it would have been obvious to one of ordinary skill in the art to have added a step of applying ultrasonic vibrations to the substrate and electrolyte as taught by Downes, Jr et al to the method of Tzanavaras et al because the ultrasonic vibrations would have increased wetting of the small vias and holes present on the substrates of Tzanavaras et al.

5. Claims 2, 3, 7, 8, 10, 21, 22 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tzanavaras et al (US 5,421,987) in view of Downes, Jr et al (US 2002/0189637) as applied to claim 1 above, and further in view of Langer et al (US 4,834,842).

The teachings of Tzanavaras et al and Downes, Jr et al are described above.

Neither of these references expressly teach that the electrolyte plating bath included an inhibitor additive.

Langer et al (see abstract and col. 1, lines 18-34) a conventional additive for copper electroplating baths included inhibitors. The inhibitors were added to ensure a uniform deposit.

Therefore, it would have been obvious to one of ordinary skill in the art to have added an inhibitor as taught by Langer et al to the electrolyte of Tzanavaras et al because the inhibitor increased uniformity of the electroplated metal.

Regarding the limitation of claims 7, 21 and 25 that the substrate included that the field and sidewalls of the surfaces comprised an exposed metallic surface, Tzanarvaras et al teach (see Example 1) that the substrate was subjected to sputter deposition of a 1000 angstrom thick seed layer. Such conventional sputter deposited seed layers coated not only the field (top surface), but also the bottoms and sidewalls of any openings on the surface.

Regarding claims 3, 8 and 10, Downes, Jr et al teach using a specific wetting solution for the wetting step and a different solution for the plating step, and even performing the wetting step in a first chamber and the plating step in a second chamber. Thus, Downes, Jr et al suggest using a wetting solution to perform the immersion and applying ultrasonic or megasonic vibration steps in a first chamber, and Tzanavaras et al would suggest using an electrolyte solution for the electroplating step in a second chamber.

Regarding claim 22, vias having metallic bottom surfaces and non-metallic sidewall surface, typically made by drilling through a printed circuit board, were known

to be conventional in the art as evidenced by the teachings of Downes, Jr et al in the abstract.

6. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tzanavaras et al (US 5,421,987) in view of Hackett (US 5,368,634).

Tzanavaras et al teach (see figure 1) a method for electrofilling a metal or alloy inside at least one opening located in a front surface of a substrate, the front surface of the substrate including at least one opening and a top field surrounding the opening, wherein the opening included a bottom and sidewalls coated with an exposed metallic surface, wherein the steps of the method included immersing the substrate in an activation solution (electrolyte), applying high pressure electrolyte jets to the substrate, wherein the electrolyte included metallic ions of the metal to be plated and applying an electroplating current to the substrate to electroplate the metal inside the opening.

Thus, Tzanavaras et al fail to teach applying ultrasonic or megasonic vibrations to the substrate prior to the onset of electroplating.

Hackett teaches (see abstract, figures 1-5, col. 1, line 5 to col. 2, line 25 and the paragraph spanning cols. 4 and 5) that when immersing semiconductor wafers having blind vias having diameters of 10-30 micrometers with depths of 100 micrometers into a solution, such as an acidic aqueous electroplating solution, sufficient wetting of the blind vias became difficult due to air bubbles remaining in the vias. Hackett teaches that a solution to the problem of these air bubbles included drawing a vacuum above the liquid in which the wafer was immersed and applying a mechanical impulse to the wafer to

dislodge the air bubble. The mechanical impulse could be applied by using an ultrasonic wave to dislodge the air bubble.

Therefore, it would have been obvious to one of ordinary skill in the art to have added a step of immersion of the substrate into a solution and applying ultrasonic wave vibrations to the solution and substrate as taught by Hackett to the method of Tzanavaras et al because the ultrasonic vibrations would have increased wetting of the blind vias having diameters in the range of 10-30 micrometers present on the substrates of Tzanavaras et al.

7. Claims 2-5, 7-11 and 21-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tzanavaras et al (US 5,421,987) in view of Hackett (US 5,368,634) as applied to claim 1 above, and further in view of Langer et al (US 4,834,842) with evidence from Downes, Jr et al (US 2002/0189637, for claims 22 and 24 only).

The teachings of Tzanavaras et al and Hackett are described above.

Neither of these references expressly teach that the electrolyte plating bath included an inhibitor additive.

Langer et al (see abstract and col. 1, lines 18-34) a conventional additive for copper electroplating baths included inhibitors. The inhibitors were added to ensure a uniform deposit.

Therefore, it would have been obvious to one of ordinary skill in the art to have added an inhibitor as taught by Langer et al to the electrolyte of Tzanavaras et al because the inhibitor increased uniformity of the electroplated metal.

Regarding the limitation of claims 7, 21, 23, 25 and 27 that the substrate included that the field, bottom surface and sidewalls comprised an exposed metallic surface, Tzanarvaras et al teach (see Example 1) that the substrate was subjected to sputter deposition of a 1000 angstrom thick seed layer. Such conventional sputter deposited seed layers coated not only the field (top surface), but also the bottoms and sidewalls of any openings on the surface.

Regarding claims 3, 8 and 10, Hackett teaches using a specific wetting solution for the wetting step and a different solution for the subsequent plating step, and even performing the wetting step in a first chamber and the plating step in a second chamber. Thus, Hackett suggests using a wetting solution to perform the immersion and applying ultrasonic or megasonic vibration steps in a first chamber, and Tzanavaras et al would suggest using an electrolyte solution for the electroplating step in a second chamber.

Regarding claims 4, 5, 9, 11, Hackett teaches (see paragraph spanning cols. 5 and 6) that after the removal of the bubbles within the blind vias, the substrate was transferred to a different chamber for performing electroplating. Hackett further notes that care must be taken during the transfer process to keep the substrate submerged in solution, and that if the substrate was exposed to air, a new set of bubbles could be introduced. Therefore, one of ordinary skill in the art would have been motivated to eliminate the transfer step to avoid the possible introduction of new bubbles to the substrate. Thus, it would have been within the expected skill of a routineer in the art to have incorporated the vacuum and ultrasonic structures into the electroplating cell of Tzanavaras et al to allow the wetting process of Hackett to occur without the need for

transferring the substrate from one chamber to another. Further, Hackett teach (see claim 9) that the liquid used in the wetting step was an aqueous electroplating solution (i.e.-the wetting solution was the same as the electrolyte).

Regarding claims 22 and 24, vias having metallic bottom surfaces and non-metallic sidewall surface, typically made by drilling through a printed circuit board, were known to be conventional in the art as evidenced by the teachings of Downes, Jr et al in the abstract.

Regarding claims 26 and 28, through holes were conventional in the art of semiconductor devices, as shown by the discussion in col. 1 of Hackett.

8. Claims 6 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tzanavaras et al (US 5,421,987) in view of Hackett (US 5,368,634) and Langer et al (US 4,834,842) as applied to claim 5 and 11 above, and further in view of Reynolds (US 5,904,827).

Tzanavaras et al and Hackett fail to teach applying the ultrasonic vibrations during the electroplating treatment.

Reynolds teaches (see abstract, figure 3 and related description) including an megasonic transducer (90-92) for agitating the electrolyte in a copper electroplating process.

Therefore, it would have been obvious to one of ordinary skill in the art to have continued applying the ultrasonic vibrations to the substrate and electrolyte as taught by Reynolds to the method of Tzanavaras et al and Downes, Jr et al because the

ultrasonic vibrations would have increased uniformity of the electroplating (see Reynolds at col. 8, lines 45-56).

Response to Amendment

9. The declaration under 37 CFR 1.132 filed 22 December 2006 is insufficient to overcome the rejection of claims 1 and 7 based upon Tzanavaras et al in view of Downes, Jr et al as set forth in the last Office action because: Applicant's characterization of the teachings of Downes, Jr et al is inconsistent with the actual teachings of Downes, Jr et al. Particularly, Applicant states that Downes, Jr et al teach that the wetting problem occurred in narrower, higher aspect ratio holes or vias and that wider, lower aspect ratio holes or vias had less of a wetting problem, where as Applicant discovered that the wetting problem is more prevalent in wider, lower aspect ratio openings. It is noted that the problem here is the use of relative terminology. When comparing the actual sizes disclosed by Downes, Jr et al (see col. 1) of 0.001-0.002 inches (25.4-50.8 micrometers) and by Applicant (see declaration) of 17 and 55 micrometers, it is clearly evident that the difficulty in wetting noted by Downes, Jr et al is the same difficulty in wetting noted by Applicant since both Downes, Jr et al and Applicant note the problem in holes/vias of the *same size*. Therefore, Applicant's comparison data with respect to the wetting problem being for different sizes is not found persuasive.

Response to Arguments

10. Applicant's arguments filed 22 December 2006 have been fully considered but they are not persuasive. Applicant has argued that:

a. Tzanavaras et al teach away from any further combination that would improve wetting of the substrate.

In response, Applicant is mischaracterizing the teachings of Tzanavaras et al. A mere statement in a reference that good agitation is achieved does not constitute a teaching away preventing the addition of further features that improve wetting of features on the substrate. In fact, Tzanavaras et al was silent with respect to the ability of the jets to achieve adequate wetting of features by removing bubbles existing in the features. Therefore, Applicant's assertion that Tzanavaras et al teaches away from the combination is not persuasive.

b. Downes, Jr et al teach that the wetting problem occurred in narrower and higher aspect ratio holes or vias.

In response, as addressed above in paragraph no. 9, the actual dimensions taught by Downes, Jr et al of the holes and vias that had the wetting problem are the exact same dimensions noted as having the wetting problem by Applicant.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Harry D. Wilkins, III whose telephone number is 571-272-1251. The examiner can normally be reached on M-F 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy V. King can be reached on 571-272-1244. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Harry D Wilkins, III
Primary Examiner
Art Unit 1742

hdw